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KEATING DENTAL ARTS, INC.

IN THE UNITED STATES DISTRICT COURT

FOR THE CENTRAL DISTRICT OF CALIFORNIA

SOUTHERN DIVISION

JAMES R. GLIDEWELL DENTAL CERAMICS, INC. dba GLIDEWELL LABORATORIES, Plaintiff, v. KEATING DENTAL ARTS, INC. Defendant.	Civil Action No. SACV11-01309-DOC(ANx) **NOTICE OF ERRATA RE DECLARATION OF DR. DAVID W. EGGLESTON IN SUPPORT OF KEATING DENTAL ARTS, INC.'S MOTIONS FOR SUMMARY JUDGMENT** <u>HEARING:</u> Date: December 21, 2012 Time: 10:00 a.m. Crtrm: 9D Honorable David O. Carter
AND RELATED COUNTERCLAIMS.	

Defendant Keating Dental Arts, Inc. ("Keating") respectfully submits this *Notice of Errata* to address inadvertent errors in Keating's papers filed with the Court in the Declaration of Dr. David W. Eggleston in Support of Keating Dental Arts, Inc.'s Motion for Summary Judgment ("Eggleston Declaration") (Docket No. 93).

Please make the following corrections to the exhibits attached to the Eggleston Declaration:

- Replace existing Exhibit 69 with Exhibit A attached hereto (corrects the exhibit number); and
- Replace existing Exhibit 76 with Exhibit B attached hereto (replaces an incorrect document (Two copies of Ex. 90 were incorrectly submitted as both 76 and 90)).

Keating apologizes for any confusion or inconvenience.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: December 20, 2012

By: /s/ Lynda J. Zadra-Symes
Lynda J. Zadra-Symes
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KEATING DENTAL ARTS, INC.

EXHIBIT A

EXHIBIT 69

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Effect of working side interferences on mandibular movement in bruxers and non-bruxers

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SUMMARY The effect of working interference on 13 bruxers and 14 non-bruxers was studied by applying a metal overlay on the buccal cusps of the adjacent upper premolar and molar. The pattern and velocity of cyclic movement during gum chewing before and after overlay insertion were observed. EMG of the temporalis and masseter muscles was recorded bilaterally during the chewing movement. It was found that after insertion, one of the non-bruxers complained of pain in the muscles, while such a complaint was not found in bruxers. Bruxing habit was reported to be less or eliminated in 44% of the bruxers, but no non-bruxers became bruxers. The closing velocity was more often decreased immediately after overlay insertion, and the closing path near the occlusal phase was significantly narrower, with patterns of over-extension and avoidance before reaching the occlusal phase. The delayed effects were a more vertically oriented chewing cycle without over-extended closing movement, and an unretarded chewing velocity. It was concluded that within the experimental period a working side interference was tolerable in most of the subjects studied with or without a bruxing habit.

Introduction

While the importance of dental occlusion on the occurrence of temporomandibular disorders (TMD) has been debated (De Boever, 1979; Krogh-Poulson, 1980; Pullinger, Seligman & Solberg, 1988), emotional factors such as anxiety and stress have been emphasized as main factors related to muscle hyperactivity, which in turn caused muscle spasm and pain-dysfunction of the muscles and joints. Occlusal alteration, if present, is a result, not a cause of TMD (Laskin, 1969; Yemm, 1971; Laskin & Block, 1986). Although the occlusal factor is no longer as important as when TM joint compression was thought to result from the loss of posterior teeth (Goodfriend, 1933; Costen, 1934), it can be a triggering factor or a sustaining factor for the pain and dysfunction of the muscles and joints (Weinberg, 1979; Ramfjord & Ash, 1983).

Among the types of occlusal alterations that have been considered as contributing factors of TMD, centric prematurity is the one most often discussed (Ramfjord, 1961; Ramfjord & Ash, 1983) while the next is a balancing interference (Perry, 1957; Schaerer, Stallard & Zander, 1967; Shore, 1976; Ramfjord & Ash, 1983; Magnusson & Enbom, 1984). Both centric and balancing interferences are related to bruxism or parafunctional jaw movement (Ramfjord, 1961; Posselt, 1971; Krogh-Poulson, 1980; Rugh, Barghi & Drago, 1984) and have a strong impact on the development of muscle fatigue and pain.

There have been relatively few studies concerning the effect of working side interferences on the masticatory system. Ramfjord & Ash (1983) stated that working side interferences seldom trigger abnormal muscle activity unless the subject has a bruxing habit. They are not as important as centric and balancing interferences on the function and health of the masticatory system. However, this type of interference is often seen, especially when a group function type of occlusion is provided with dental restorations.

Hannam *et al.* (1981) applied acrylic working interferences on posterior teeth of normal subjects and found

an altered chewing pattern and an inconsistent change of muscle activity and jaw displacement. No harmful influence from the addition of working side interferences was found. However, the study was concerned with the immediate effect only. Shiau & Ash (1989) used a metal overlay as a working side interference on normal subjects and found that 14% of non-bruxers complained of pain on the second day. They also found an altered chewing pattern, reduced closing velocity, and premature contraction of the closing muscles. There could be adaptation to all of the altered patterns in one day. However, it is unknown if the working side interferences have been applied on bruxers who have more vigorous tooth contact.

The purpose of the present study was to apply working side interferences on both bruxers and non-bruxers and to observe and compare their immediate and delayed responses.

Materials and methods

Subjects

Fourteen non-bruxers (6 males and 8 females) and 13 bruxers (9 males and 4 females) were examined in this study. All were students and staff of the School of Dentistry, National Taiwan University and its dental clinic. Their ages ranged from 18–31 years. All the bruxers had reports from their roommates, spouses or family that they often made grinding noises at night. Their dentition also showed non-functional wear facets that appeared shiny and well demarcated. Three of them had occasional muscle stiffness in the morning, but none had pain in their jaw muscles or TM joints. The non-bruxers did not have a bruxing report and their teeth did not show attrition facets with sharp borders. Both of the groups had complete dentitions, nearly intact dental occlusion, and asymptomatic masticatory muscles and TMJ.

Procedures

A metal overlay was made on the stone cast of the upper second premolar and first molar on the habitual chewing side. It was approximately 1·5 mm in thickness at the cusp tip area and excluded the other teeth during lateral excursion without causing a centric prematurity. The overlay was adjusted at the chair side and prepared to be seated with an acid etch resin cement*.

Session W0

Before the working side interference was applied, the subject was seated upright in a dental chair with the head supported. Paired surface electrodes (Ag/AgCl) were attached over the centre of the belly of the anterior temporalis, masseter and anterior digastric muscles. Muscle activity was amplified in a 12-channel EMG†. Jaw motion was recorded using a light-emitting diode (LED) system‡. The LED was positioned in a clutch luted on the labial surface of the lower incisors. The muscle activity and the jaw motion in two dimensions were recorded with an FM tape recorder§ and replayed on an X-Y plotter.

The subject was asked to perform the following movements: centric contact, right and left lateral excursion, and opening from right and left extreme positions. A piece of gum was then chewed and softened before recording of chewing movement was started.

Session W1

Immediately after session W1, the overlay was luted on the chosen teeth and the contact condition was checked. The same recording procedure as used in W0 was then performed without changing the electrodes and LED placement.

Sessions W2, W3 and W4

These sessions were performed 1 day, 1 week and 1 month after overlay insertion. The electrodes were replaced so that they were at the centre of each muscle belly. The same clutch and LED were re-used during these sessions.

Measurement of chewing movement and EMG during gum chewing before and after overlay insertion was made on 10 consecutive chewing cycles started from cycle no. 5 to cycle no. 14. As seen in Fig. 1, the angle formed in the frontal plane between the closing path and the vertical axis was considered the angle of closing path (∠AC). The closing path measured was that within the range of 3 mm of vertical separation from the centric occlusion phase. The angle formed between the axis of

* Panavia EX, Kuraray Co. Ltd., Okayama, Japan.
† EP12 Polyanalyser, OTE Biomedica, Firenze, Italy.
‡ Saphon Visi-Trainer CIII, Tokyo Shizaisha Co., Tokyo, Japan.
§ 3968 A Instrumentation Recorder, Hewlett Packard, Palo Alto, U.S.A.

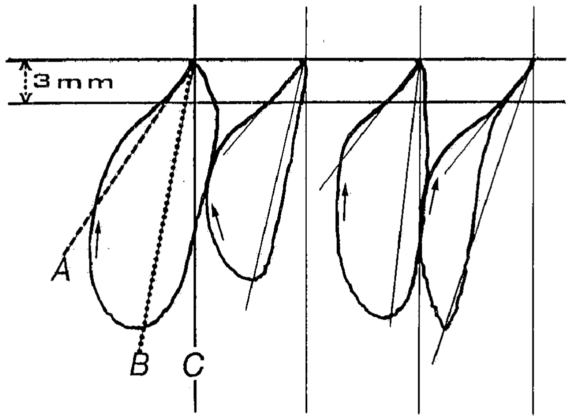

Fig. 1. Measurement of the angle of closing path and the chewing axis. ∠AC = angle of closing path; ∠BC = angle of chewing cycle axis.

the chewing cycle and the vertical axis was considered the angle of chewing axis (∠BC). The differences in EMG and jaw motion among five sessions and between the bruxers and non-bruxers were analysed and compared intra- and interindividually. ANOVA and the Student's *t*-test were applied for data analysis. Statistically significant differences were those with $P < 0.05$.

Results

The insertion of the overlay immediately changed the pattern of border movements. Six of the 14 non-bruxers (42·9%) had an increased border area and eight (57·1%) had a decreased border area. In bruxers, eight (61·6%) had an increased border area and five (38·4%) had a decreased area. In addition, one of the non-bruxers (7·1%) complained of pain in his masseter muscles at session W2, while none of the bruxers had a pain complaint throughout the observation period. The overlay was removed from the painful subject for ethical reasons and the pain disappeared in 3 days. At session W2, two non-bruxers (14·3%) and four bruxers (30·8%) found that the overlay was detached. The experiment in these six subjects was discontinued. In the remaining nine bruxers, four of them (44·4%) reported less frequent or no bruxing during the experimental period, and none of them reported more bruxing. In the non-bruxer group, none reported bruxing after insertion of the overlay. Their reports were confirmed by their roommates, spouses or family.

Nine of the 14 non-bruxers showed a narrower closing angle at session W1. As seen in Table 1, the mean ∠AC at W0 was 41·2 ± 13·3 degrees vs. 28·1 ± 14·7 degrees at W1; the difference being significant ($P < 0{\cdot}05$). At sessions W2, W3 and W4, ∠AC was about 30°. In bruxers, the mean ∠AC at W0 was 40·2 ± 6·7° and at W1 was 32·0 ± 7·7° ($P < 0{\cdot}05$). The closing angle at W2, W3 and W4 was approximatly 30°. The difference between W0 and the other sessions was also significant ($P < 0{\cdot}05$). The difference in ∠AC between bruxers and non-bruxers was not significant at any of the sessions.

The axis of chewing cycle in the frontal plane became slightly more vertically oriented at W1 and the sessions thereafter. However, the difference in ∠BC between W0 and the other sessions was not significant statistically ($P > 0{\cdot}05$).

Alteration of the chewing pattern not only was found during the closing path near the centric position, but also during the closing path before entering the occlusal table. Four (28·6%) of the non-bruxers and five (38·5%) of the bruxers developed an overextended closing path at W1. The mandible moved more laterally at the begining of the closing movement and remained in the lateral position until meeting the tip of the overlay or even beyond it before sliding back to centric position along the lingual contour of the buccal cusps (Fig. 2). The pattern of the overextended closing path was seen at sessions W1 and W2 in non-bruxers and W1 only in bruxers.

Another type of altered closing path was the pattern of avoidance in which the closing movement was more vertically oriented. The mandibular cusps did not seem to contact the lingual surface of the overlay before reaching centric position (Fig. 2).

The closing velocity during gum chewing at different sessions is shown in Table 2. The average closing velocity

Table 1. Angle of closing path (∠AC) measured at five sessions on bruxers and non-bruxers

	Non-bruxers			Bruxers		
	X̄	s.d.	CV(%)	X̄	s.d.	CV(%)
W0	41·2	13·3	32·3	40·2	15·6	38·8
W1	28·1*	14·7	52·3	32·0*	14·6	45·6
W2	32·1*	15·3	47·7	32·0*	12·8	40·1
W3	30·8*	13·7	44·5	26·8*	8·9	33·1
W4	30·5*	15·9	52·1	29·4*	9·3	31·6

CV: coefficient of variance; *: significant difference ($P < 0{\cdot}05$) between W0 and other sessions; W0 to W4: sessions, before and after overlay insertion.

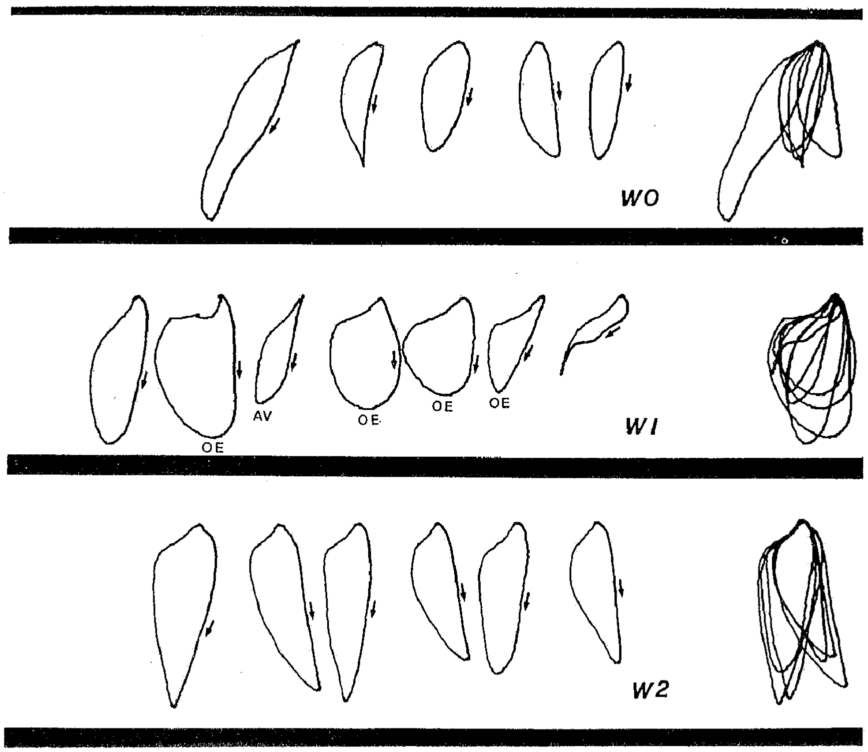

Fig. 2. Patterns of gum chewing before and after overlay insertion. Note the pattern of overextention (OE) and avoidance (AV) at W1 and W2.

of non-bruxers at W0 was not significantly different from that of bruxers (closing velocity: 51·8 ± 18·3 mm/s vs. 45·0 ± 21·7 mm/s; opening velocity: 44·5 ± 12·8 mm/s vs. 45·5 ± 15·1 mm/s). Because of the wide variety in the chewing velocity between individuals it was difficult to find a significant change of either opening or closing velocity at W1 or sessions thereafter. However, if observed individually, as seen in Fig. 3, there were nine non-bruxers (64·3%) and seven bruxers (53·8%) who had the closing velocity decreased at W1. At W2, 75% of the non-bruxers and 72% of bruxers had the closing velocity increased up to the level of W0 or even higher. At sessions thereafter, the closing velocity generally maintained a higher than W0 level, with less fluctuation than from W0 to W2. Opening velocity on average was slower than closing velocity. At W1, 35·7% of non-bruxers and 38·5% of bruxers showed decreased opening velocity. At session W2, 66·6% of non-bruxers and 50·0% of bruxers increased their opening velocity. Again at sessions W3 and W4, the opening-velocity became more stable in both non-bruxers and bruxers.

The contraction period of the temporalis muscle during gum chewing was about 250 ms in non-bruxers and 262 ms in bruxers at session W0. Immediately after overlay insertion, it became significantly longer (285 ms in non-bruxers and 290 ms in bruxers, $P<0{\cdot}05$). At sessions W2, W3 and W4, the average contraction period returned to the level of W0 (Table 3). Duration of mas-

		W0		W1		W2		W3		W4	
		O	C	O	C	O	C	O	C	O	C
Non-bruxer	X̄	44·5	51·8	51·8	49·1	57·3	58·7	59·1	65·7	57·7	63·6
	s.d.	12·8	18·3	15·4	17·9	12·8	12·9	12·5	14·5	12·9	16·6
Bruxer	X̄	45·5	45·0	51·2	40·8	57·5	49·0	52·6	52·5	52·5	58·0
	s.d.	15·1	21·7	13·0	17·7	18·2	28·6	5·0	7·2	8·9	15·6

Table 2. Opening and closing velocity during gum chewing in bruxers and non-bruxers at different sessions (in mm/s)

O: opening velocity; C: closing velocity; W0 to W4: sessions, before and after overlay insertion.

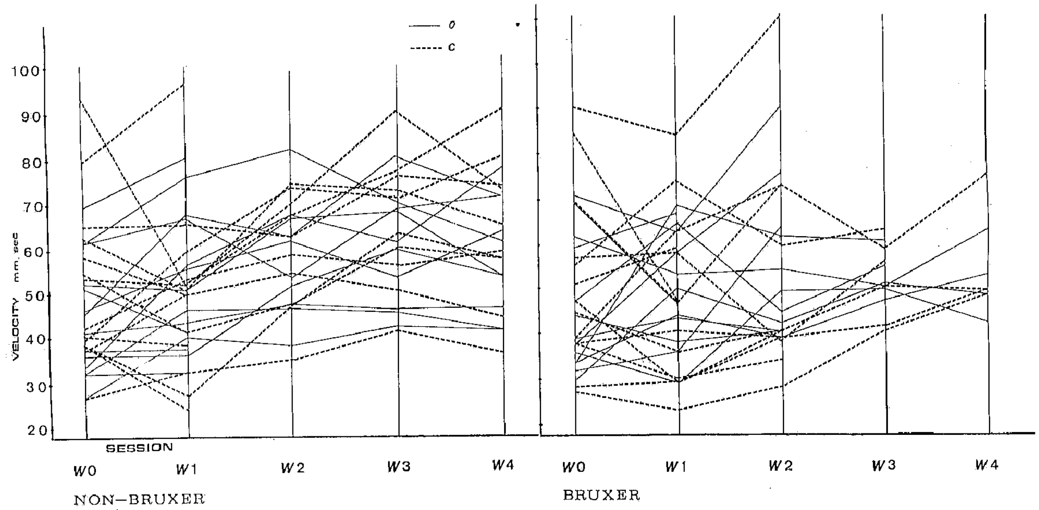

Fig. 3. Velocity change of opening and closing movement during gum chewing at five sessions. O = opening velocity; C = Closing velocity.

seter muscle activity was generally slightly shorter than that of the temporalis, but its change with sessions was about the same. As seen in Fig. 4, the prolonged contraction period basically corresponded to the appearance of an overextended closing movement. No difference in the contraction period was seen between non-bruxers and bruxers.

Discussion

The velocity of jaw closing movement decreased immediately after overlay insertion in most of the non-bruxers and bruxers, suggesting an awareness and avoidance of the working side contact on the metal overlay. Two types of avoidance were found in this study. The first type appears to be a normal lateral movement during the early part of the closing path and a restricted movement later near occlusion. The more mesially or vertically oriented chewing cycle axis was another type of avoidance, which represents an adjustment of the cyclic movement after contacting the overlay. Hannam *et al.* (1981) also proposed the concept of avoidance related to the presence of a working side interference. In addition to the pattern of avoidance, there is a more characteristic response to the working side interference involving an overextended closing path. It seems that the mandible moved more laterally to touch and detect the existence of the prematurity or to try to grind it away. The higher incidence of overlay detachment in bruxers also suggested more frequent and stronger grinding on the overlay in bruxers who had more often tooth contact both in the daytime and at night.

Table 3. Contraction period of jaw closing muscles during gum chewing in non-bruxers and bruxers at sessions before and after overlay insertion (in ms)

	W0	W1	W2	W3	W4
	X̄ s.d.	X̄ s.d.	X̄ s.d.	X̄ s.d.	X̄ s.d.
Non-bruxer					
Temporalis	250 ± 48	285 ± 86*	265 ± 48	244 ± 50	258 ± 65
Masseter	237 ± 68	270 ± 78*	243 ± 96	226 ± 54	238 ± 90
Bruxer					
Temporalis	262 ± 52	290 ± 75*	260 ± 62	255 ± 54	248 ± 72
Masseter	228 ± 74	289 ± 68*	236 ± 61	240 ± 45	233 ± 49

*: significant difference ($P < 0{\cdot}05$) between W0 and W1; W0 to W4: session, before and after overlay insertion.

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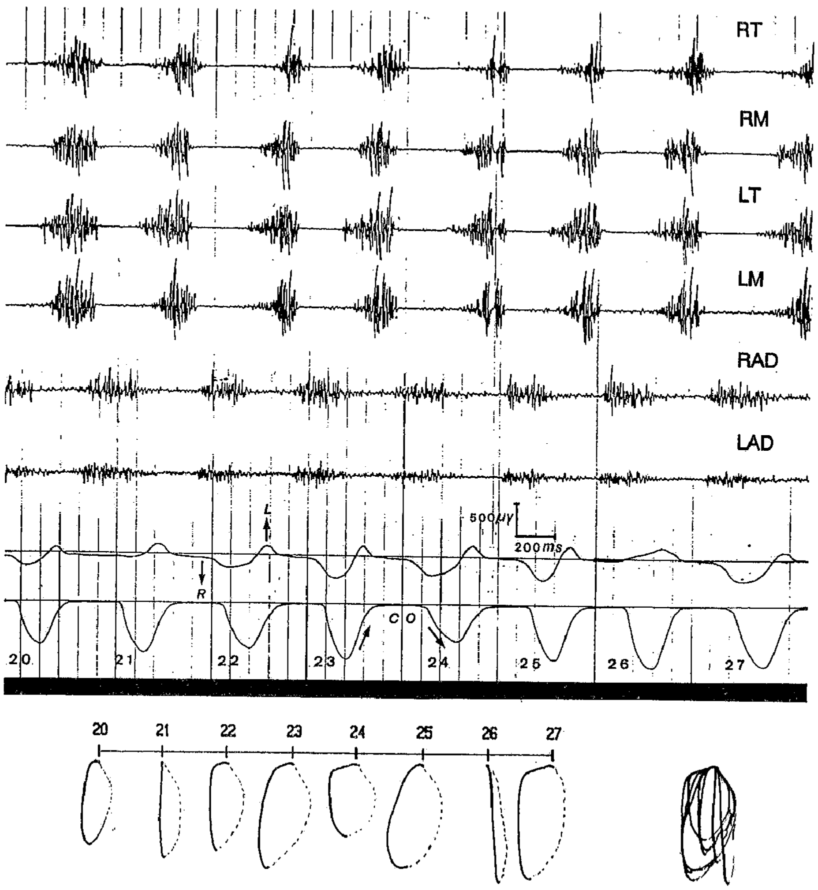

Fig. 4. Duration of muscle contraction during right side gum chewing of a non-bruxer at session W1. RT = right temporalis; RM = right masseter; LT = left temporalis; LM = left masseter; RAD = right anterior digastric; LAD = left anterior digastric. Horizontal scale 200 ms, vertical scale 500 μv. The last two tracks are the jaw movement on X (right and left) and Y (up and down) dimensions. The corresponding number of chewing cycles is shown at the bottom. Solid line: closing path; shaded line: opening path.

It is not easy to judge if the reports of decreasing bruxing habit at night in some bruxers in this study is an outcome of overlay application. Rugh *et al.* (1984) applied a metal crown with deflective contact on a molar of bruxers and found a decrease of muscle activity at night. They concluded that the occlusal factor did not elicit nocturnal bruxing even in subjects with a bruxing history. Furthermore, it had been suggested that addition of canine guidance on a group function occlusion could immediately reduce the activity of the jaw closing muscles (Manns, Chan & Miralles, 1987). The bruxers with a buccal overlay probably can also reduce their muscle tension and do less bruxing. However, because of the lack of a more objective way to monitor the bruxing activity at night, and the evidence of a high overlay detachment rate in the bruxer group, it is difficult to draw a similar conclusion in this paper. The verbal report of less bruxing from the bruxers might be based on a less evident bruxing noise normally noticed by their roommates, but not necessarily on less bruxing.

Subjects who had a narrow closing angle without earlier contraction of jaw closing muscles probably did not make any gliding contact on the overlay or buccal cusps of the upper teeth during jaw closure. The neuromuscular system tried to avoid the contact of the overlay by limiting the lateral movement of the jaw during closure. The change of the apperance of an overextended lateral closing movement depends upon the subject's response to the presence of the working side interference. It seems that the bruxers had slightly better awareness and a stronger response.

At session W2, both non-bruxers and bruxers resumed their closing velocity to the level of W0 and the incidence of overextended closing movement was much reduced. This might suggest that adaptation to the working side interference occurred within 1 day. The insignificant change of ∠BC and the smaller ∠AC at sessions W1 and thereafter suggested that they adapted to the new situation by limiting the lateral extension of the closing movement in 1 day or less.

The velocity change in both the non-bruxers and

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bruxers after session W2 was not as significant as was seen at W1. The velocity of jaw movement, especially during closure, increased fairly consistently and became even faster than before the insertion of the overlay. This phenomenon could be the result of repeated practice when the subjects became familiar with the overlay and the LED tracking system. It had been shown that the border movement of the jaw traced with the LED system can become broadened after visual feedback training and practice (Wang & Shiau, 1987). The increased opening and closing velocity at sessions W2, W3 and W4 might also suggest the effect of practice and accommodation. We believe that the addition of the overlay did have a strong impact on chewing velocity making it significantly slower at session W1 rather than faster, as would be expected due to practice.

According to the findings of this study on chewing velocity, chewing cycle pattern and symptoms, it is difficult to suggest that a working side interference often causes substantial change in the masticatory system even when the interference was applied on bruxers and stayed for 1 month. From the findings of this report and previous studies (Hannam *et al.*, 1981; Shiau & Ash, 1989), we believe that a working interference is not an important factor that can be related to the TMD symptoms. However, the results of this study could not confirm the findings and suggestion of Rugh *et al.* (1984) that an occlusal interference could reduce the bruxing activity of bruxers. The higher overlay detachment rate in bruxers in this study suggests more frequent or more powerful jaw movement at night in some bruxers, although their verbal report indicated no bruxing.

Acknowledgment

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EXHIBIT B

EXHIBIT 76

The effect of bruxism on periodontal sensation in the molar region: A pilot study

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Statement of problem. Periodontal sensation in individuals with bruxism may differ from that in nonbruxers, as excessive amounts of occlusal force may be applied to the teeth during the night. However, this concept is not adequately addressed in the literature.

Purpose. The purpose of this study was to investigate the effects of bruxism on periodontal sensation in the molar region.

Material and methods. Fourteen dental school faculty and students lacking objective or subjective abnormalities of stomatognathic function were divided into 2 groups representing nonbruxers (n=7) and bruxers (n=7). Bruxism was confirmed based on the nocturnal electromyography activities of the masseter muscle. Periodontal sensation was assessed based on interocclusal tactile threshold, which refers to the minimal thickness that can be detected between the occlusal surfaces of the teeth. Interocclusal tactile threshold was measured in the first molar region each for the left and right sides by placing variable thicknesses of metal foil and recording the threshold twice daily (morning and afternoon) on 3 separate days. Multivariate ANOVA was performed for bruxism (with or without) as a between-subjects effect, and time of day (morning and afternoon) and side (left and right) as within-subjects effects (α=.05)

Results. Multivariate ANOVA revealed no significant differences in interocclusal tactile threshold between morning and afternoon or between the left and right sides in either group. The mean (SD) interocclusal tactile threshold for the bruxers was 17.1(3.9) μm, while that for the nonbruxers was significantly greater at 29.9(5.6) μm (P<.001).

Conclusions. The periodontal sensation in bruxers was increased compared to nonbruxers. (J Prosthet Dent 2007;98:30-35)

Clinical Implications

Periodontal sensation is different for bruxers relative to nonbruxers and care should be taken when adjusting and correcting occlusal contacts for fixed prostheses.

Sensory receptors in the periodontium are closely involved in various oral reflexes, as well as in reflex control of the masticatory muscles.[1-5] These receptors that sense external force applied to teeth are the periodontal mechanoreceptors and intradental mechanoreceptors.[4,6] Periodontal sensation can be measured by 2 methods. One method measures the detection of forces applied to the teeth using monofilaments (von Frey hair).[7-10] The other method measures the detection of thickness of small objects such as strips placed between maxillary and mandibular teeth.[10-14] Tactile detection threshold (TDT) refers to the minimal force that can be

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detected; interocclusal tactile threshold (ITT) refers to the minimal thickness that can be detected.

Bruxism is a harmful oral habit caused by occlusal and psychological factors[15] in which excessive amounts of occlusal force are applied to the teeth.[16] As excessive occlusal force is applied to the teeth for long periods of time during the night, periodontal sensation in bruxers may differ from that in nonbruxers. Mantyvaara et al[8] investigated the effects of bruxism on periodontal sensation in terms of TDT and found that the TDT of maxillary central incisors did not differ significantly between individuals with nocturnal bruxism and those without. However, the periodontal sensation of molars, which primarily receive occlusal force, is not clear.

Periodontal sensation when adjusting and correcting occlusal contact for fixed prostheses should be considered because of different individual reactions to occlusal contact. Therefore, clarifying the effects of bruxism on periodontal sensation is useful for the maintenance and management of fixed prostheses. The purpose of this study was to investigate the effects of bruxism on periodontal sensation in the molar region in terms of ITT, which is an indicator of occlusal contact. The research hypothesis was that ITT in bruxers differs from that in nonbruxers.

MATERIAL AND METHODS

This study measured the ITT in the first molar region to compare bruxers to nonbruxers and to confirm the difference between the right and left sides and the effect of the passage of time after nocturnal bruxism. The subjects were 14 dental school faculty and students without objective and subjective abnormalities of stomatognathic function (age range: 24 to 28 years; average: 25.9 years). All subjects had a stable maximum intercuspation position and no crowns or prostheses covering the occlusal surfaces of the left and right first molars. The protocol of this study was approved by the Ethics Committee of Showa University School of Dentistry and informed consent was obtained from each subject.

Subjects were asked whether they were aware of bruxism. The nocturnal activities of the masseter muscle were then measured using a portable surface electromyography (EMG) machine (EMG-021/025, KTR-2302B; Harada Electronic Industry Ltd, Sapporo, Japan) (Fig. 1). Subjects were shown how to use this device, and they were able to measure the EMG correctly before taking it home. EMGs were recorded from the right and the left masseter muscles during 1 night at each subject's home. Bruxism was confirmed based on the diagnostic standards proposed by Lavigne et al.[17] Seven subjects who were aware of bruxism satisfied these diagnostic standards. The other 7 subjects who were not aware of bruxism did not satisfy the diagnostic standards (Table I).

For ITT measurements, 1.5 x 1.5-mm pieces of aluminum foil (Nippon Foil Mfg Co Ltd, Tokyo, Japan) with thicknesses of 5, 10, 15, 20, 25, 30, 35, 40, and 45 μm were used. This range of foil thickness was determined according to previous studies in which thicknesses ranged from 10 to 35 μm,[11] from 8 to 32 μm,[13] and from 10 to 50 μm.[14] Each subject was asked to sit in a dental chair, and after the occlusal contact area on the mesial buccal cusp of the mandibular first molar was confirmed using articulating paper (GC Corp, Tokyo, Japan), a piece of aluminum foil was placed on this area (Fig. 2). The subject was asked to occlude 5 times and to indicate whether or not he/she was able to detect the presence of the piece of foil between the occlusal surfaces of the teeth. On each try, the thickness of foil from 5 to 45 μm was changed, and the minimal thickness that could be detected was considered the ITT. ITT was measured on the left and right sides independently, twice daily (morning and afternoon), in order to confirm the effects of the passage of time after nocturnal bruxism. Each

1 Portable surface electromyography machine.

TABLE I. Confirmation of bruxism based on diagnostic standards proposed by Lavigne et al.[17] Bruxism bursts were defined as EMG potentials with amplitude of at least 20% of maximum voluntary contractions. Bruxism episodes were phasic, tonic, or mixed (both phasic and tonic) episodes. Phasic episode corresponds to at least 3 EMG bursts of 0.25 to 2.0 seconds in duration, separated by 2 interburst intervals. Tonic episode corresponds to EMG burst lasting more than 2.0 seconds. Numbers under cutoff were criteria for diagnosis of sleep bruxism

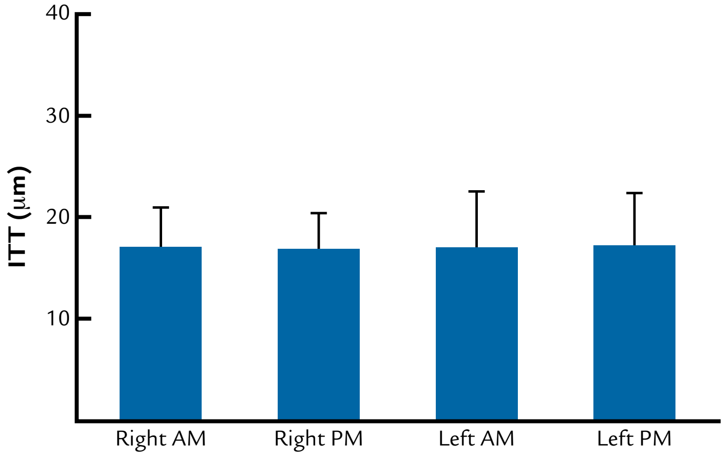
		Number of Subjects	
Variables	**Cutoff**	**Bruxers**	**Nonbruxers**
Number of bruxism episodes per night	>30	0	0
Number of bruxism episodes per hour	>4	1	0
Number of bruxism bursts per episode	>6	6	0
Number of bruxisms per hour	>25	0	0

2 Metal foil placed on mesial buccal cusp of mandibular first molar.

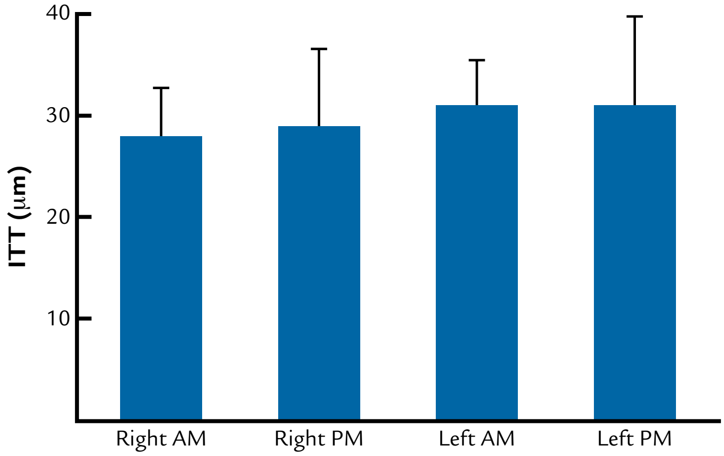
ITT was measured on 3 separate days in order to confirm the difference between days. Multivariate analysis of variance (MANOVA) was performed using statistical software (JMP, version 4.0; SAS Institute Inc, Cary, NC) for bruxism (with or without) as a between-subjects effect, and time of day (morning and afternoon) and side (left and right) as within-subjects effects (α=.05).

RESULTS

For the bruxers, the mean (SD) right-side ITT in the morning and afternoon was 17.1(3.8) and 16.9(3.5) µm, respectively, while mean left-side ITT in the morning and afternoon was 17.1(5.3) and 17.4(4.9) µm, respectively (Fig. 3). For the nonbruxers, mean (SD) right-side ITT in the morning and afternoon was 28.1(5.3) and 29.9(7.5) µm, respectively, and mean left-side ITT in the morning and afternoon was 31.2(4.3) and 31.2(8.6) µm, respectively (Fig. 4). Table II shows the results of MANOVA which revealed no significant differences in ITT between morning and afternoon or between the left and right sides. ITT in the nonbruxers ranged from 20 to 45 µm, and that in the bruxers ranged from 5 to 20 µm. Overall mean SD ITT for the bruxers and nonbruxers was 17.1(3.8) and 29.9(5.6) µm, respectively, and this difference was significant (P<.001) (Fig. 5).



3 Mean ITT values for bruxers. Vertical lines represent SDs. MANOVA revealed no significant differences in ITT between morning and afternoon or between left and right sides.

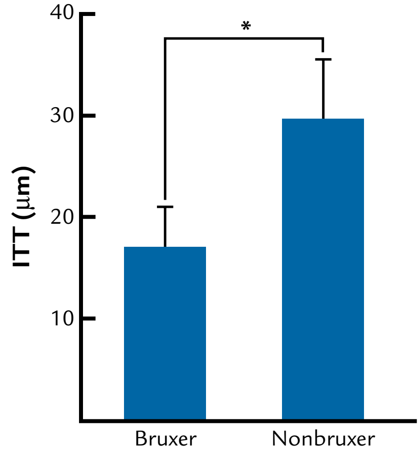


4 Mean ITT values for nonbruxers. Vertical lines represent SDs. MANOVA revealed no significant differences in ITT between morning and afternoon or between left and right sides.

TABLE II. MANOVA results for ITT within and between subjects

Effect		**Value**	**Exact F**	**Num *df***	**Den *df***	***P***
Within subjects	AM x PM	0.004	0.051	1	12	.824
	Right x left	0.128	1.534	1	12	.239
Between subjects	Bruxers x nonbruxers	2.04	24.475	1	12	<.001

Value = statistical value of multivariate test; Exact F = F value corresponding to multivariate test; Num *df* = numerator degrees of freedom; Den *df* = denominator degrees of freedom; *P* = significance probability corresponding to F value



5 Overall mean ITT values in bruxers and nonbruxers. Vertical lines represent SDs. MANOVA revealed significant differences in ITT between bruxers and nonbruxers (*P<.001).

DISCUSSION

The results from this study indicated that ITT in bruxers differs from that in nonbruxers and, thus, support the research hypothesis. The present method for testing ITT in the molar region produced similar values as reported by other authors.[10-14] Mean (SD) ITT in the bruxers was 17.1(3.8) μm and that in the nonbruxers was significantly higher at 29.9(5.6) μm. The effects of bruxism on periodontal sensation were previously reported in terms of TDT by Mantyvaara et al.[8] The authors found no significant differences in the TDT of maxillary central incisors between individuals with or without nocturnal bruxism. In the present study, ITT was used as an indicator for periodontal sensation, and in contrast to the previously mentioned study, ITT in the bruxers was significantly lower than that in the nonbruxers. In other words, the threshold for periodontal sensation was lower in the bruxers. TDT varies depending on loading method, loading direction, and tooth type,[7,9] and when compared with ITT, in which thickness is assessed while maxillary and mandibular teeth are in contact, the mechanism for detecting external force may differ for TDT. The receptors that sense external force applied to teeth are the periodontal mechanoreceptors and intradental mechanoreceptors.[4,6] Either one or both types react to mechanical stimulation to the periodontium, but the mode of response to these receptors varies depending on the type of stimulation. While periodontal mechanoreceptors respond to stimulation with a wide range of stimulation velocities, intradental mechanoreceptors respond to fast stimulation, such as tapping.[4,6] ITT may involve not only periodontal mechanoreceptors, but also intradental mechanoreceptors; therefore, the results of this study differed from those reported by Mantyvaara et al.[8]

For both the bruxers and nonbruxers, there were no significant differences in ITT between the morning and afternoon or between the left and right sides. Because there are no significant differences in ITT between incisors and molars,[12] ITT may be equal for all teeth in each individual. When compared with the nonbruxers, the threshold for periodontal sensation was lower in the bruxers, and as a result, the periodontal masseteric reflex is more likely to be induced, resulting in persistent and potent muscular activity. However, it is not clear whether bruxism lowers ITT or low ITT causes bruxism. Because psychological stress has been shown to induce bruxism,[15] bruxism can affect ITT at the level of the periodontium, as well as at the level of the central nervous system. Further investigation is necessary to elucidate an onset mechanism.

Clinically, periodontal sensation when adjusting and correcting occlusal contact for fixed prostheses should be considered in that individuals with bruxism react differently to occlusal contact than nonbruxers. There are several limitations to this study. The sample size was small, and the subjects were selected from a narrow age range (24 to 28 years). Nevertheless, the present study suggests that periodontal sensation in bruxers seems to increase compared to that in nonbruxers. Further investigation is necessary to increase the number of subjects from a wider age range and to investigate whether all low ITT individuals are bruxers or high ITT individuals are nonbruxers.

CONCLUSIONS

Within the limitations of this study, the mean ITT (SD) for the bruxism group was 17.1(3.9) μm, while that for the control group was significantly greater at 29.9(5.6) μm (P<.001). Periodontal sensation in bruxers was increased compared to that in nonbruxers.

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Noteworthy Abstracts of the Current Literature

Bone strains around immediately loaded implants supporting mandibular overdentures in human cadavers

Akca K, Akkocaoglu M, Comert A, Tekdemir I, Cehreli MC.
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Purpose. To compare the biomechanical effect of splinted versus unsplinted mandibular implants supporting overdentures subjected to experimental static immediate load on bone tissue deformation using strain gauge analysis.

Materials and Methods. Strain gauges were bonded on the labial cortical bone adjacent to 2 Straumann dental implants placed in the mandibular interforaminal region of 4 completely edentulous mandibles of fresh human cadavers. The installation torque value (ITV) of each implant was measured using a custom-made torque wrench, and implant stability quotients (ISQs) were also obtained using resonance frequency analysis. Three overdentures (ODs), 2 splinted (bar- and cantilevered bar-retained) and 1 unsplinted (ball-retained), were fabricated for each edentulous mandible. Two experimental loads were applied subsequently via 2 miniature load cells that were placed bilaterally 10 mm (anterior loading) and 15 mm (posterior loading) from the implant. Strain measurements were performed at a sample rate of 10 KHz and under a maximum experimental static load of 100 N; they were simultaneously monitored from a computer connected to a data acquisition system. Finally, the removal torque values (RTV) of the implants were measured.

Results. Strains on the labial cortical bone around implants supporting mandibular ODs under anterior loading were significantly higher than measured under posterior loading for all attachment types ($P<.05$). All strain values were compressive in nature, and the minimum strain (−19 με) was recorded for bar-retained ODs under 25 N posterior loading, while the maximum strain (−797 με) was recorded for retentive anchor-retained ODs under 100 N anterior loading. Nonparametric correlations between ISQs, ITVs, and RTVs identified significant correlations only for ITVs and RTVs ($P<.05$).

Conclusion. Splinting of 2 interforaminal dental implants, regardless of attachment type, to support mandibular ODs subjected to immediate load significantly reduced initial bone tissue strains experienced on the labial cortical bone in comparison with the use of unsplinted implants.